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(FOR PRIVATE CIRCULATION.)

ST. LAWRENCE BRIDGE
AND
MANUFACTURING SCHEME.

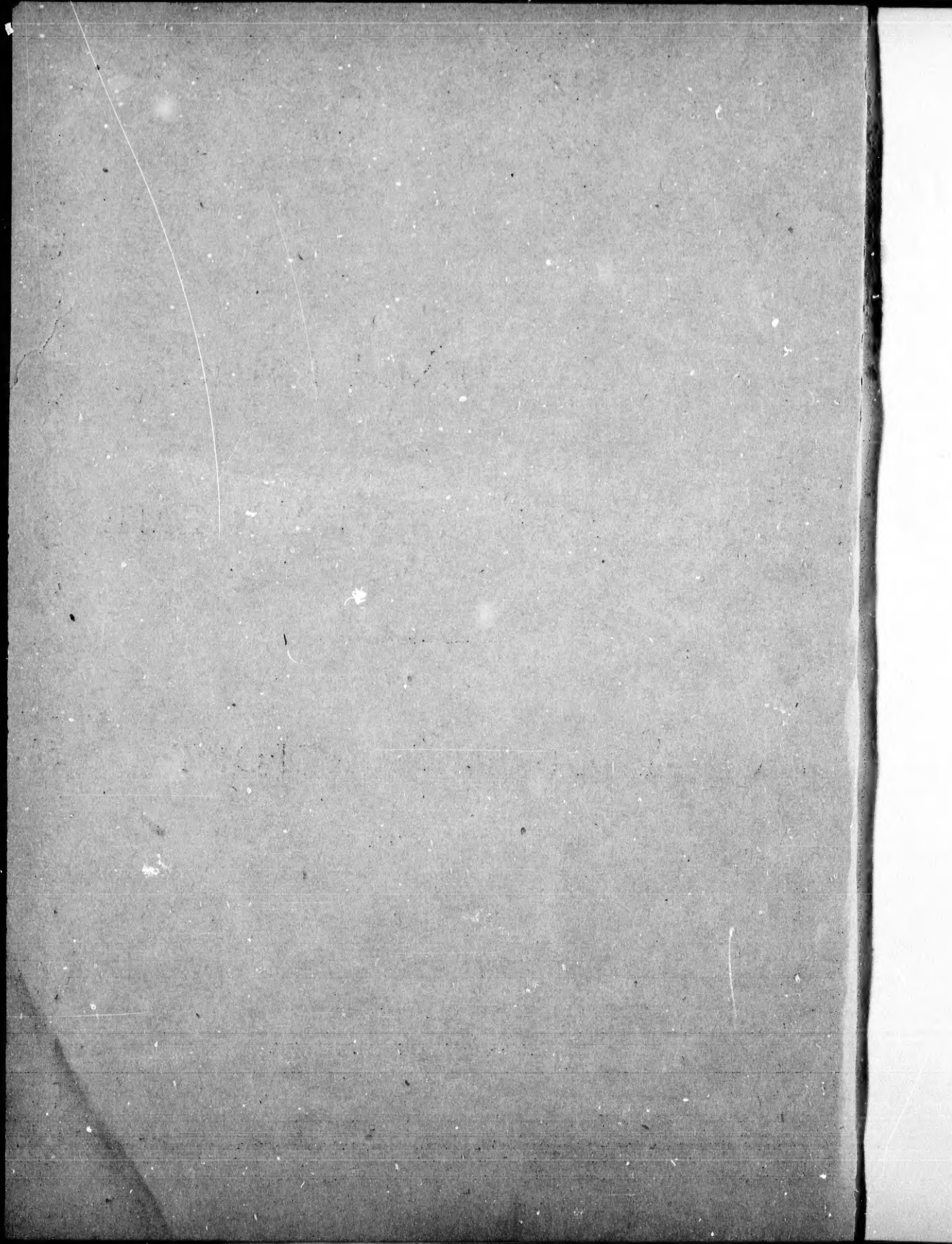
(Greater Scheme)

ENGINEER'S REPORT

18th January, 1882.

MONTREAL :
DAWSON BROTHERS.

1882.



ST. LAWRENCE BRIDGE
AND
MANUFACTURING SCHEME.

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18th January, 1882.

MONTREAL :
DAWSON BROTHERS.

1882.

March 14 1871

Dear Sir

I have the honor to acknowledge the receipt of your letter of the 10th inst.

and in reply to inform you that the same has been forwarded to the proper authorities.

I am, Sir, very respectfully,
Your obedient servant,

Wm. J. Hobbs

3 Molsons Bank Chambers,

MONTREAL, 18th January, 1882.

To

SIR H. L. LANGEVIN, C.B.

Minister of Public Works

OF THE DOMINION OF CANADA.

THE ST. LAWRENCE BRIDGE AND MANUFACTURING SCHEME.

SIR,

In accordance with the instructions received from you on the 12th January, 1882, I have the honor to lay before you my report on the above scheme, together with such plans and sections as are necessary to fully explain the intentions and propositions of the applicants for the charter. Instructions.

I propose in the first place to set down the general outline and explanation of the proposed works; how we propose constructing them; how during the time of construction they will affect the harbour; the approximate cost; and the advantages which we maintain will accrue to the harbour after the completion. I next propose dealing with the possible objections which may arise to the scheme, by the turning a part of the water of the St. Lawrence through the South Channel; how this will affect the low lying lands above Victoria Bridge, and at Longueuil, and the shore of the Montreal Island at Hochelaga. Lastly, I propose dealing with the question of lowering the water of the harbour, and the effect from ice forming in the harbour on the navigation in connection with the Lachine Canal. Outline of Report.

The works will consist of an embankment running from the North-West corner of the Western abutment of the Victoria Bridge, to a point on the South side of St. Helen's Island, and of a high level bridge from thence, across the river to the South shore of the St. Lawrence between St. Lamberts and Longueuil. Description of proposed works.

The embankment will be 76 feet wide at the top, with a solid masonry wall on the river side, and will be left on the harbour side in an unfinished condition, at a slope of 3 to 1, until such time as the requirements of the harbour of Montreal may necessitate from time to time the finishing of portions on that side. The Embankment

A highway 30 feet wide, with a trottoir 10 feet wide, and a double track of rails will run along the embankment. The top of the masonry wall on the outer or river side of the embankment, at the point at which it starts, (the North West corner of the West abutment of Victoria Bridge) will be of the same height as that abutment, or about 30 feet above the ordinary level of the St. Lawrence. It will run thence to St. Helen's Island, rising gradually to a height of 60 feet above the ordinary water level, which height it will attain when it arrives at the point at which the proposed bridge will commence. Highway and Railroad Track.

**Controlling
sluices.**

The embankment will be provided with three series of controlling sluices. These sluices will be capable of passing into the harbour 486 million cubic feet of water per hour, and will be placed at a depth of 11 feet 6 inches below the ascertained low level of the water of the St. Lawrence. These sluices will be entirely under the control of the Harbour Board, and should be kept closed during the winter months when navigation has ceased, and only opened again when it is required to open up the harbour in the Spring, when navigation again commences; during the Summer when the harbour water requires raising; or for controlling and regulating floods.

**Mill and manu-
facturing sluices.**

The embankment will further be supplied with 35 sluices, for milling, lifts and manufacturing purposes. These sluices will be capable of discharging into the harbour about 364 million cubic feet of water per hour. They should be generally superintended and controlled by the Harbour Board, but will be used at the same time independently and without restriction for the above-mentioned purposes.

**Total yield to har-
bour from sluices.**

These two quantities taken together give a yield to the harbour from the Upper St. Lawrence of 850 million cubic feet per hour.

**Highway and Rail-
road.**

The highway and railroad will run along the embankment, having connection with the different lines running to Montreal, with a gradient of about 1 in 250, to the point on St. Helen's Island from which it is proposed to throw the bridge across the river.

The Bridge.

The bridge will have a total length of 3,050 feet from abutment to abutment, and will be formed of unattached lattice girders, with spans of from 250 to 294 feet. These will be placed on solid masonry piers with cut-waters such as are on the Victoria Bridge, and these piers will be 10 in number. Or, should the Government require it, a suspension bridge will be substituted for the above, with 4 openings. The double track of rails and highway will run across the bridge to the South Shore, whence they will connect with the different railroads and highways of the district. The highway across the bridge will be reduced to 25 feet in width, with a foot-path of 6 feet wide.

**Difficulties of con-
struction.**

Little difficulty is to be apprehended in the construction of the works, as, with the exception of one place known as the "horse shoe" or "pocket," the work of both embankment and bridge will be executed entirely in shallows, which during the summer months are generally dry. The foundations of the embankment will be either in solid rock, or in strong blue shale. The foundations of the abutment and piers of the bridge will be in solid rock, and with one exception, can be built entirely in the dry. For these reasons the cost of the works will be comparatively small.

**Interests not to
be affected during
construction of the
works.**

Care will have to be taken that during the construction of the works, no alteration should be made in the flow of water into the harbour, and that no interference should occur to local navigation interests; and for this purpose the deep channel hereinafter referred to will have to be made for steamers to pass round into the harbour, and such other temporary works as will assure a plentiful supply of water to the harbour. These temporary works will be included in the estimate.

It is proposed to remove Mofiat's Island, the old Grand Trunk Wharf, and all existing obstructions in the South Channel, and to straighten and widen the South Channel at the points coloured red on the plan. It is further proposed to straighten and widen the channel between Isle Ronde and St. Helen's Island, so as to allow a maximum quantity of water, amounting to some 85 million cubic feet per hour, to pass through into the harbour, thereby with the sluices increasing the discharge into the harbour to 935 million cubic feet per hour exclusive of the Lachine Canal.

Clearing the South Channel.

Discharge into harbour through channel between Ile Ronde and St. Helen's Island.

A channel will also be excavated on the South side of St. Helen's Island 300 feet wide, with a uniform depth of 10 feet below the present bed of the stream, so that during very dry weather in the Summer, when all the sluices are discharging full into the harbour, navigation in the South Channel may not be impeded for want of water.

Deep channel for navigation.

Wherever either above or below the proposed works, it may be necessary owing to low lands likely to be flooded, a levee will be built.

Levees.

The approximate cost of the works, including all contingencies, will from estimates that I have carefully taken out amount to Three Million two hundred thousand dollars, (\$3,200,000).

Approximate cost of the works.

It is claimed by the promoters, and I think with reason, that the advantages to the harbour of the carrying out of the scheme, will be very considerable. In the first place the harbour will not be lowered, but the Harbour Board will be able by means of the sluices, to so control and regulate the water in the harbour, as to keep it at a uniform depth throughout, and, having once deepened it in the different portions to whatever depth they may consider desirable, it will not again be necessary to proceed with the same amount of dredging as heretofore; as all the large quantity of detritus which is now brought down by the ice, and deposited in the deep portions of the harbour, will be done away with, and only such small amount of sediment as may be created by local causes, will settle in the harbour. This when the water is very high can be scoured out by the discharge from the large sluices. The St. Mary's Channel will, when the sluices are running full bore, have only a velocity of 5 miles per hour as against the present velocity, which has been carefully ascertained by means of meters and floats, of $8\frac{1}{2}$ miles per hour; and these observations were taken when the River St. Lawrence was remarkably low. The rapid current between Sous-le-Mont and Ile Verte which has a velocity of 12 miles per hour will be completely done away with.

Advantages to the harbour.

Detritus.

The navigation interests will be in no degree injured, as the La Prairie and other boats will be able to land passengers on the South or River side of the embankment, or pass down the excavated channel into the harbour, and the South Channel will have at no point a greater velocity than 7 miles per hour.

Navigation interests.

With regard to the low lying lands between La Prairie and Victoria Bridge, the result of the investigations that I have made, is that the proposed alterations would only create a rise of the water at Victoria Bridge of about 4 feet 6 inches, and as the lowest land in the neighbourhood of La Prairie is some 11 feet above the level of the water at this point, it is impossible that the jamming of ice in

Lowland near La Prairie.

the lower portion of the St. Lawrence having raised the water above Victoria Bridge to the height that it generally does at these times, should alter the height of water at La Prairie and the adjoining lands themselves.

Questions of deepening the South Channel.

Obstacles.

Moffat's Island and Grand Trunk Wharf.

Currents and causes of their present direction.

Return of current to natural channel.

Rise of water in South Channel.

Levees.

Hochelaga.

It is not therefore in my opinion in any way necessary to deepen the South Channel, further than removing such obstacles as might actually present a surface to the uniform flow and drift of water and ice respectively, except in the case of the channel for navigation 300 feet wide and 18 feet deep, before and hereinafter referred to. Such obstacles are presented by Moffat's Island, the Grand Trunk Wharf, and the adjacent rocks. Moffat's Island and especially the Grand Trunk Wharf are two of the most serious impediments to the flow of water down the South Channel. On the 31st December, 1881, I carefully tested the height of the water on one side of the Grand Trunk Wharf and on the other, and found a difference of level of one foot 8 inches in height on the upper side. I found also that the current from Victoria Bridge which I carefully tested was setting directly down the centre of the South Channel, until it met with the obstruction of the Wharf, when it was thrown across the river in the direction of the "pocket" and thence into the harbour, with a velocity of some 12 or 13 miles per hour. Previous to this, I had an opportunity of watching the current, which went far to verify the observations taken on Moffat's Island. This was at the end of Brassey's Wharf, near the Western abutment of Victoria Bridge, where I noticed that the current set in a direct line for the Grand Trunk Wharf. Messrs. Bell, Newton, and Fleming, also by their report and plans recognized this, and these facts lead me strongly to the conclusion, that formerly the South Channel of the St. Lawrence was the main channel of the river, before the Grand Trunk Wharf was built, and the softer material between St. Helen's Island and the point which is now the Western end of the Victoria Bridge, was worn away by the action of the water and ice, and that by turning a large portion of the water of the St. Lawrence down the South Channel we shall only be returning it to its original course.

It therefore appears to me better to allow the water to rise to such a height that it may pass the required quantity of water down the South Channel, both for the reason of giving sufficient head to the sluices for the control of the harbour, and because if the bed of the South Channel were lowered by the proposed scheme, the harbour would most assuredly be lowered in proportion.

Wherever it may be necessary to build a levee along the course of the South Channel for the protection of land from high water, it will be done; but it is to be observed that the main characteristics of the St. Lawrence in times of high water when the danger occurs will not be altered, as the greater portion of water can still be passed through the harbour.

With regard to the question of possible injury to the shore of the Montreal Island at Hochelaga, by the change of direction of the current, nothing in my opinion is to be feared, as it is to be remembered that the nearly still water basin between Longueuil and Hochelaga and the conditions of the river will remain precisely the same, and the change in the direction is so small, that it will have little or no effect on the deep water. Further than this a very large portion of the water can at all times, if considered necessary, be passed through the harbour sluices.

All these points I have endeavored to show clearly on the plans and diagrams attached to this report. Attached plans.

The floods of the River St. Lawrence are due almost entirely, in my opinion, to the disjointed and broken channel near and around Boucherville Island, and to the flats and shallows which according to the Admiralty Chart exist in that neighborhood. These floods are, I think, considerably aggravated in the immediate vicinity of Montreal, by the packing and cramming of ice in St. Mary's Channel, which after the ice has packed at Boucherville flats, creates a second temporary dam, and again raises the water in the Harbour. This, after the proposed works are completed, will obviously be done away with. I am informed that since the channels, lower down the St. Lawrence, have been deepened, the floods have been from 3 to 5 feet lower than previously. Floods of the St. Lawrence.

Effect of proposed works on floods.

The embankment will be built with a slightly convex side towards the river, where the ice is likely to hit or impinge upon it, as shewn on the attached plan. Design for embankment.

From information received from persons intimately acquainted with the Ice. St. Lawrence, and more especially from Mr. Kennedy, M. Inst. C. E., Chief Engineer of the Harbour Commissioners of Montreal, who has kindly given me every assistance and information in his power, during the researches and surveys that I have been obliged to make in studying the general question, it appears that the rules which can be applied to the action of ice are very indefinite, and this must naturally be so. I have, however, obtained sufficient information to guide me in arriving at the probable action of ice after the construction of proposed works. From information received from Mr. Kennedy, it appears that ice requires very little encouragement to move, either in one direction or another, and that unless a large obstacle is placed directly in its road, it will have a tendency to be guided or broken in the direction that any such obstacle may direct it. When I speak of a large obstacle, I infer such a thing as an embankment thrown at right angles or nearly so across the direction of the current, which embankment would have to be made sufficiently strong to stand the maximum pressure of any mass or masses of ice which might be shoved against it. But in the case on the other hand, of an embankment that would only alter the course of the water and ice, I fear no piling or jamming of ice against it, and as in the case of the Victoria Bridge, if the piers of the proposed bridge are properly constructed, I believe that the result will be a further breaking up of the ice after leaving Victoria Bridge, and consequently that no packing will occur in this portion of the river. My reasons for this belief are the following:—The distance between the Victoria Bridge and the proposed bridge is so short, that after having been first broken by it, the ice will not again have the chance of rapidly congealing before arriving at Ile Ronde, owing to the increased depth and the velocity in the proposed new channel.

In times of flood, as I have said before in my report, the condition of the St. Lawrence will remain exactly the same as before. The advantages with regard to the ice, which, in my opinion will no doubt be found after the completion of the works, are: that at St. Mary's Current the present jam of ice, and the further raising of the water and the flooding of the lower portions of the City of Montreal will be obviated, and in the future, no ice shoves or piling up of the ice on the wharves will occur. In times of flood.
The packing in St. Mary's Current.

Lachine Canal and
ice forming in the
harbour.

With regard to the question of ice forming in the harbour proper during the winter and probably impeding navigation in the spring from the Lachine Canal and other sources, the breaking up of the ice, in my opinion, will occur precisely as it does now, as it appears to be due to the rise of the water in the spring, which will act upon the harbour in the same manner as at present. The harbour can be controlled at any time by the sudden opening of the sluices, and this arrangement will further have the advantage of all the main ice, of the River St. Lawrence passing down the South Channel instead of passing through the harbour.

Lachine Canal
Locks.

In regard to the question of the Lachine Canal, it is improbable that the canal and locks will be freed from ice before the harbour under the proposed new conditions.

The question of
lowering the water
of the harbour.

St. Mary's Current.

If the works of the proposed embankment are built in the manner now suggested, the harbour will not be lowered at any point, except immediately at the top of the present St. Mary's Current, at which point it will be lowered about 6 inches. St. Mary's Current is due to a large extent to the water piling itself behind the narrow channel through which the current runs. From this point in a distance of only about $\frac{1}{4}$ a mile, there is a fall of from 1 foot 9 inches to 2 feet. The present height of the water in the harbour would if no water were turned into it, be lowered 2 feet 3 inches, and supposing that the whole of the St. Lawrence were passed by the South Channel into the virtually still water basin opposite Longueuil, which length of the river has only a fall of 4 inches in a mile, the water at this point immediately below Ile Ronde would remain at the same level as at present, and would return into the present harbour until that level were again found, that is 2 feet 3 inches below the present level. But

Backwater.

it is to be observed that the St. Mary's Current at present creates a backwater on the South side of Ile Ronde of about 1 foot 6 inches in height, and this backwater so far as can be ascertained, taking into consideration the alteration in the velocities between the St. Mary's Current and the nearly still water opposite Longueuil, should not be more than 10 or 11 inches. The greater height of backwater observed is owing no doubt to the abrupt fall of the bed of the South Channel, at a point above the head of the backwater, and some other local reasons. The backwater that should be created into the harbour by way of St. Mary's Current, when the whole of the water of St. Lawrence flows by the South Channel, should be about 1 foot 8 inches, which would raise the water of the harbour from the reduced level of 2 feet 3 inches to that height; and besides this, the level of the water in the harbour would be again raised by other means about 4 inches. These other supplies would come from the Lachine Canal, and the discharge through the Channel between Ile Ronde and St. Helen's Island, giving a total rise of 2 feet, or 3 inches below its present normal level. It is preferable however in dealing with this question to allow for the fact that the height of the bed of the South Channel is somewhat above the present surface of the water in the harbour, and that owing to the necessary raising of the water in the South Channel, that water will be delivered into the wide nearly still water basin opposite Longueuil with a head or depth of 3 feet, which would cause a swell or head of water immediately below Ile Ronde, for backwater, the current down the river as the case may be, of 1 foot 11 inches, and allowing for rather more than half of this going down the river, there would be a backwater of only 10 $\frac{1}{2}$ or 11 inches towards the harbour. This would only give a total rise from the reduced level in the harbour, from the Ile Ronde Channel; the Lachine Canal;

Lachine Canal and
the channel between
Ile Ronde and St.
Helen's Island.

and this backwater of about 15 inches, or a total loss to the depth of the harbour of about 12 inches.

The water on the South side of St. Helen's Island will have an average depth, at ordinary water level, of about 8 feet, except in the deep channel, 300 feet wide, which it is proposed to cut along the shallow portion, which channel will have an average depth of about 18 feet, and in no place will there be a greater current, if a suspension bridge be built, than 6 miles per hour, or 7 miles per hour if the girder bridge is built. The material from this channel, from Moffat's Island, from the adjacent rocks, and from the proposed widening of the South Channel, would be absolutely required for the construction of the embankment, and considerable further excavation would be necessary from the harbour as well, so that the proposed Company would be able to offer to the Harbour Commissioners the advantage of deepening the harbour to whatever depth might be considered necessary, within reasonable distance of the proposed site of the embankment, without any considerable extra cost to themselves.

Depth of the South Channel.

Current in the South Channel.

Advantages to be offered to the Harbour Commissioners.

From the foregoing remarks it will be seen that the water in the harbour would, with the exception of eddies, be almost still water, with a sufficient return current to carry down all sewage matter, but not in my opinion to give the Harbour Board that amount of control of the harbour which they should have in the case of the lowering of the St. Lawrence in very dry weather, and possible silting up of the deep portions of the harbour. It is for this reason that the controlling sluices have been adopted, which, if made, will considerably reduce the backwater at Ile Ronde, and I prefer, therefore, to ignore the possible and problematical effect of backwater, and to deal with the question as it absolutely exists to the public mind, of having to return or make up to the harbour the 2 feet 3 inches in depth that it will have been reduced.

Water in the harbour

Controlling sluices.

The rapid current of $8\frac{1}{2}$ miles per hour in St. Mary's Channel only exists for a distance of some 3,000 feet, in which distance there is a fall, as I before stated, of from 1 foot 9 inches to 2 feet. The surface water behind this current is piled up and creates for itself, or has created by currents above, sufficient head and under currents to force the greater part of the volume of the St. Lawrence, through the narrow channel at St. Mary's, until it arrives at the wide basin opposite Longueuil. Careful gauging with current meters and floats shew an increased rapidity in current below the surface, which current is no doubt created by the rapid current of 12 miles per hour at a point between the rocks before mentioned, Sous-le-Mont and Ile Verte, where there is a fall in 400 feet, of 2 feet 3 inches, and a velocity of 12 miles per hour. There is little doubt that this current extends to a considerable depth below the surface of the whole harbour basin, and acts with a propelling force on the St. Mary's current, and that what is apparently still water at present in the harbour is the effect of the backwater created by the sudden narrowing of the channel at Ile Ronde, and the upheaval of the water due to under currents. In fact, the true fall that should be taken in calculating the velocity of the water through the harbour, and consequently the quantity of water discharged through St. Mary's Current, is 4 feet 6 inches, and not 2 feet 3 inches, and should be registered from a point immediately above Sous-le-Mont to the still water opposite Longueuil. At present the fall of the water of the harbour is calculated to be about 2 feet 3 inches, but this is taken from the sill of the lock of the Lachine Canal to the still water opposite Longueuil,

Present currents.

Relative width of
channel.

or immediately below Ile Ronde, a distance of about 2 miles. Now it is evident that with such a fall in this distance and with no local obstruction in the bed of the stream, the St. Mary's Current would neither have the velocity of $8\frac{1}{2}$ miles per hour, nor be able to pass the quantity of water which now runs through it, and these statements can be easily verified by calculation. The width of water-way as proposed for the new channel on the South side will be 3,000 feet instead of the width of the present water-way through St. Mary's Channel of only 1,800 feet.

Sufficient water to
be passed into the
harbour.

It therefore has appeared to me advisable to provide the means for passing into the harbour a quantity of water sufficient to keep it up to its present level and somewhat above. The reason for passing more water than is absolutely necessary into the harbour is, that if only the amount required to keep the water to its present level at the top end or shallow portion of the harbour were passed through the sluices, the water at the head of St. Mary's Current would be somewhat lowered owing to the uniform velocity and fall throughout the harbour. After the embankment is made, the water in the harbour will be independent of any currents of the St. Lawrence, except those created by the water passed through the controlling and distributing sluices, and consequently it will have a uniform fall due to the head of the water. It will be found by calculation that in order to raise the water to the original level of 2 feet 3 inches when the embankment is made, St. Mary's current will have to pass through that channel 810 million cubic feet of water per hour. It will also be found by calculation, that without the help of the various currents which at present exist behind it collected together and impelled upon it, it cannot deliver more than this, or travel with greater velocity. It is proposed in order to meet this requirement of 810 million cubic feet per hour, to pass into the harbour through various sources 982 million cubic feet per hour, or 172 million cubic feet more than necessary under the then circumstances to raise the water to the original level of the harbour. The harbour Board will have the advantage of being able to regulate their own harbour and the floods of the river as they may deem necessary.

Future currents.

In closing my report I beg to hand you the accompanying plans and sections, and

I have the honor to be,

SIR,

Your obedient servant,

(Signed,)

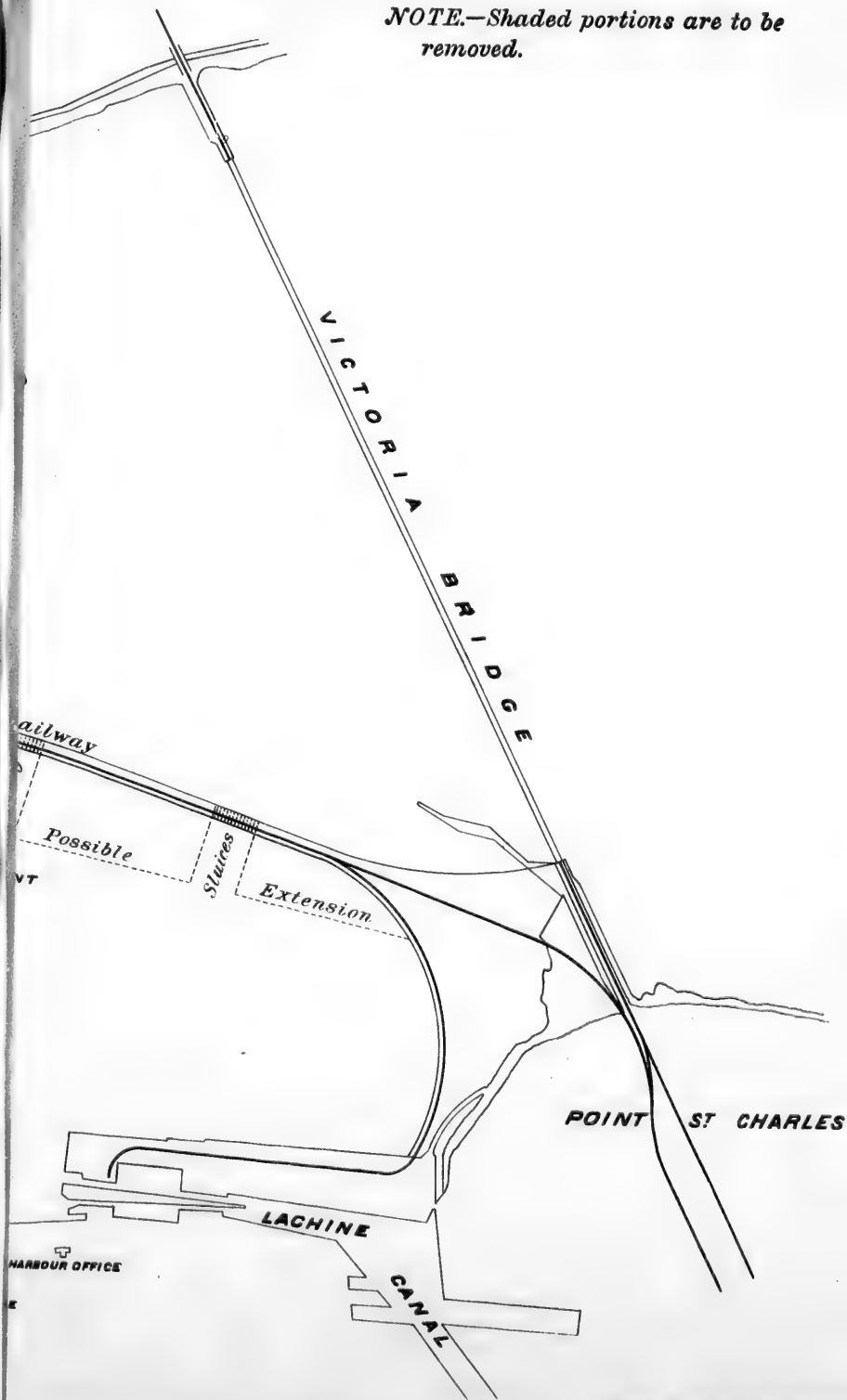
F. FOSTER BATEMAN,

M. Inst. C. E.

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Pos
VT
HARBOUR

Nº 1

NOTE.—Shaded portions are to be removed.



Scale 1,200 feet per inch.

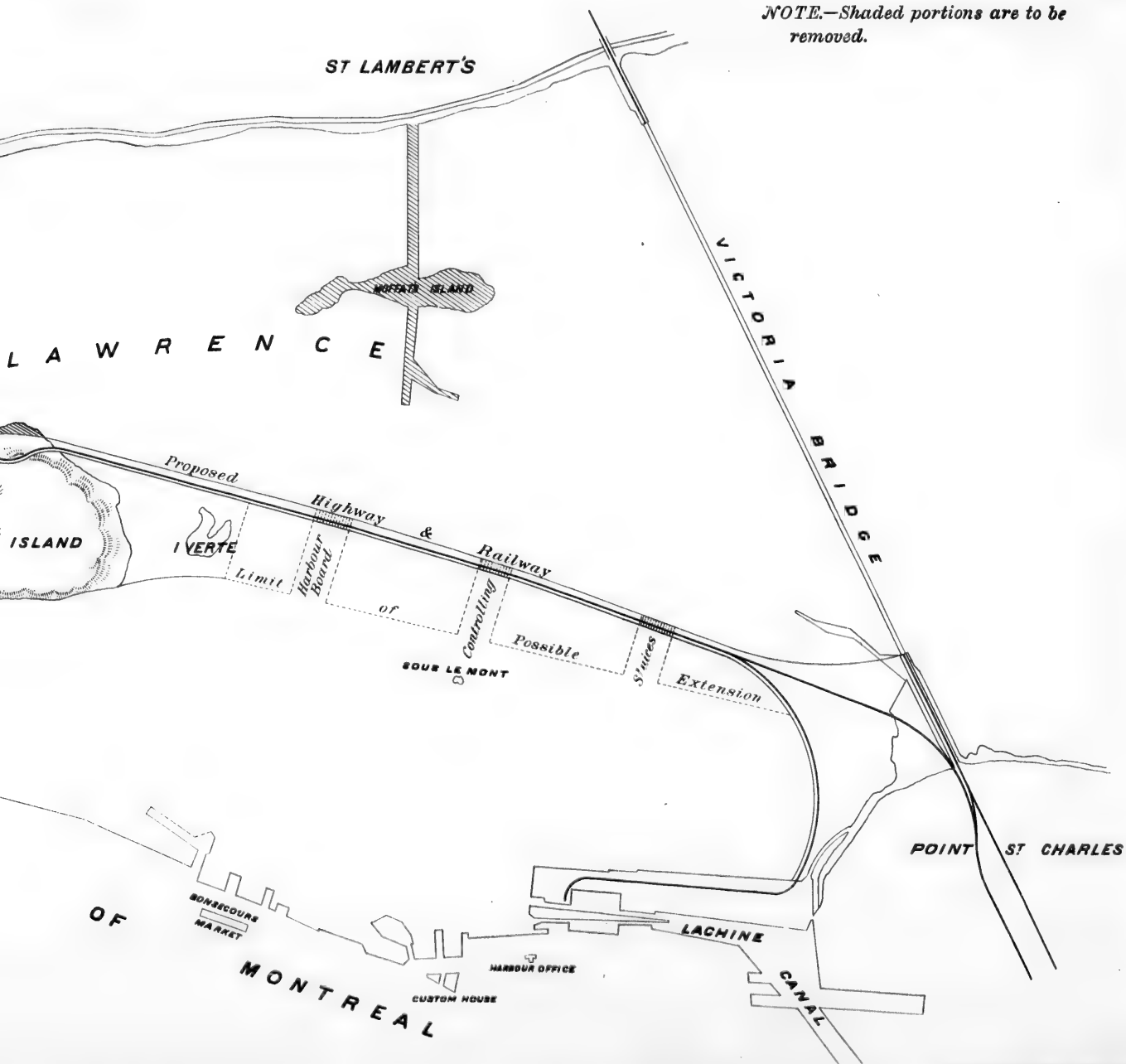
DAW ON BOYS' MONTAGE



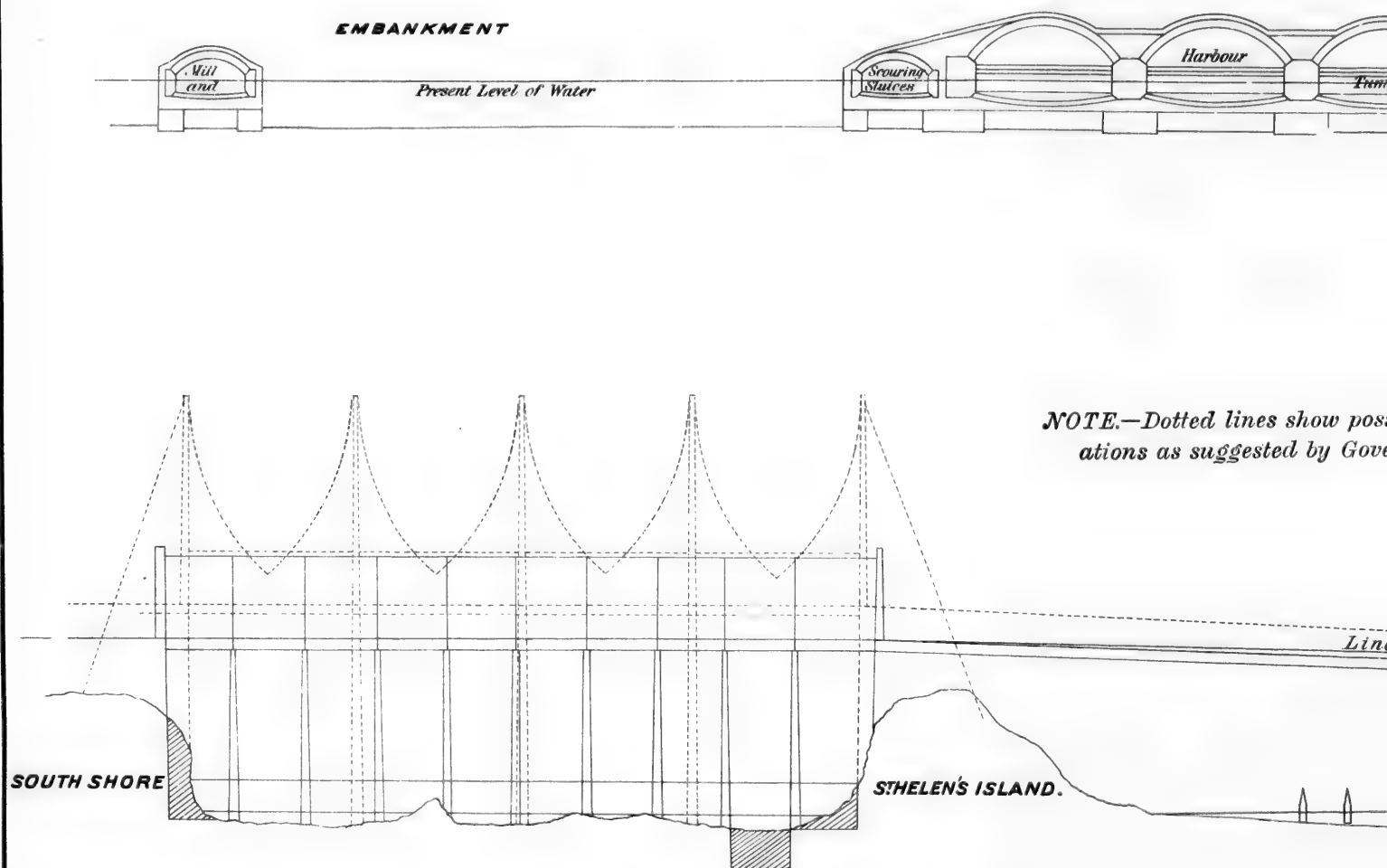
Lydia Baumeister
The Inst. C.F.

Nº 1

NOTE.—Shaded portions are to be removed.

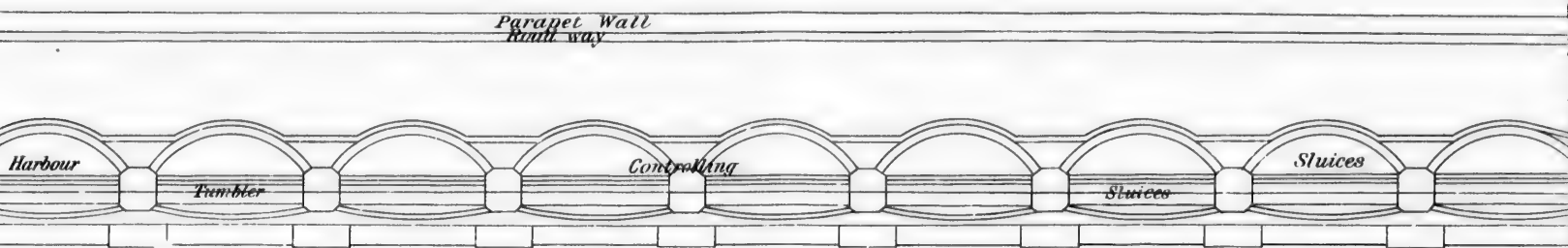


SECTIONS &c.

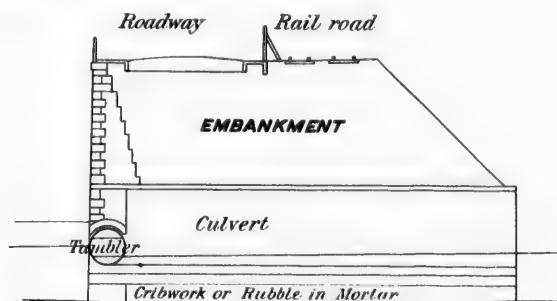


THE ST. LAWRENCE BRIDGE AND MANUFACTURING SCHEME.

Lester B. Lawrence
In 1881, C.E.



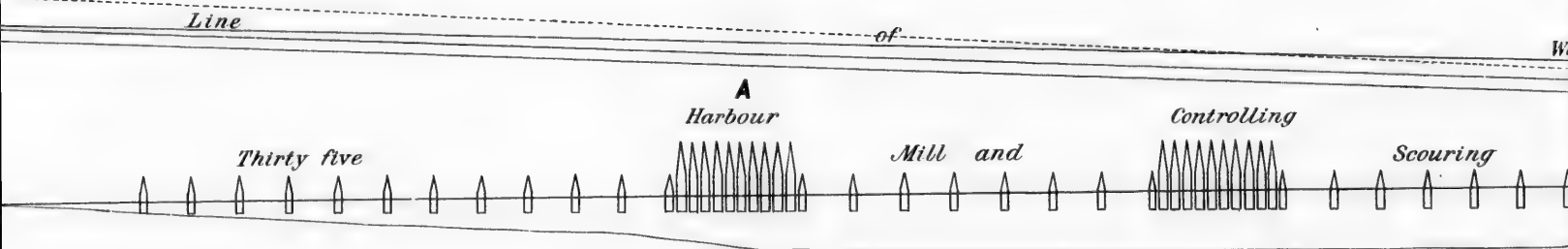
LONGITUDINAL SECTION OF EMBANKMENT AND SLUICES AT A.



Natural Scale for Sect
40 feet per inch.

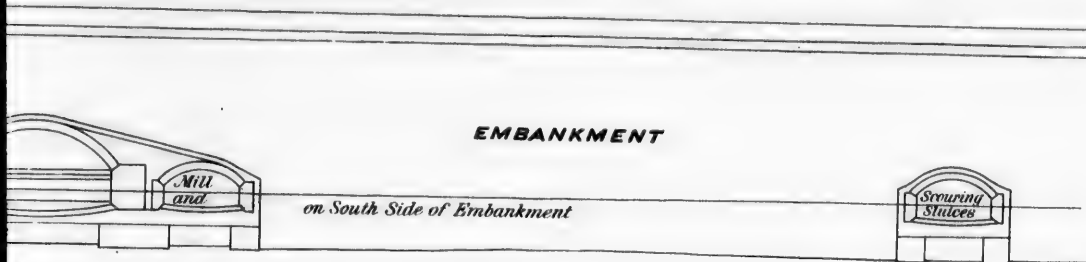
tted lines show possible alter-
s suggested by Government.

CROSS SECTION OF EMBANKMENT.



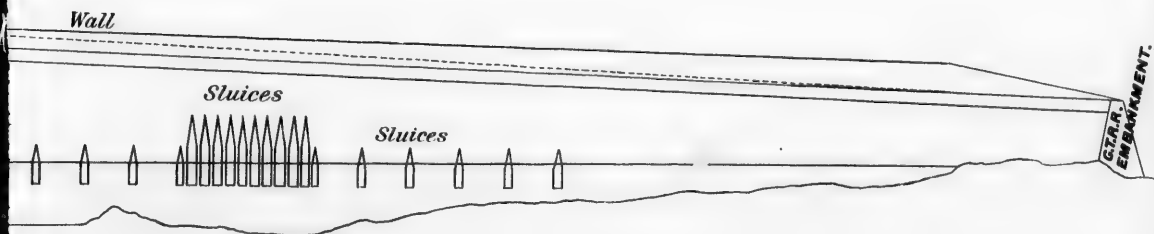
ELEVATION OF BRIDGE AND EMBANKMENT.

Horizontal Scale 600 ft. per inch.
Vertical Scale 40 ft. per inch.

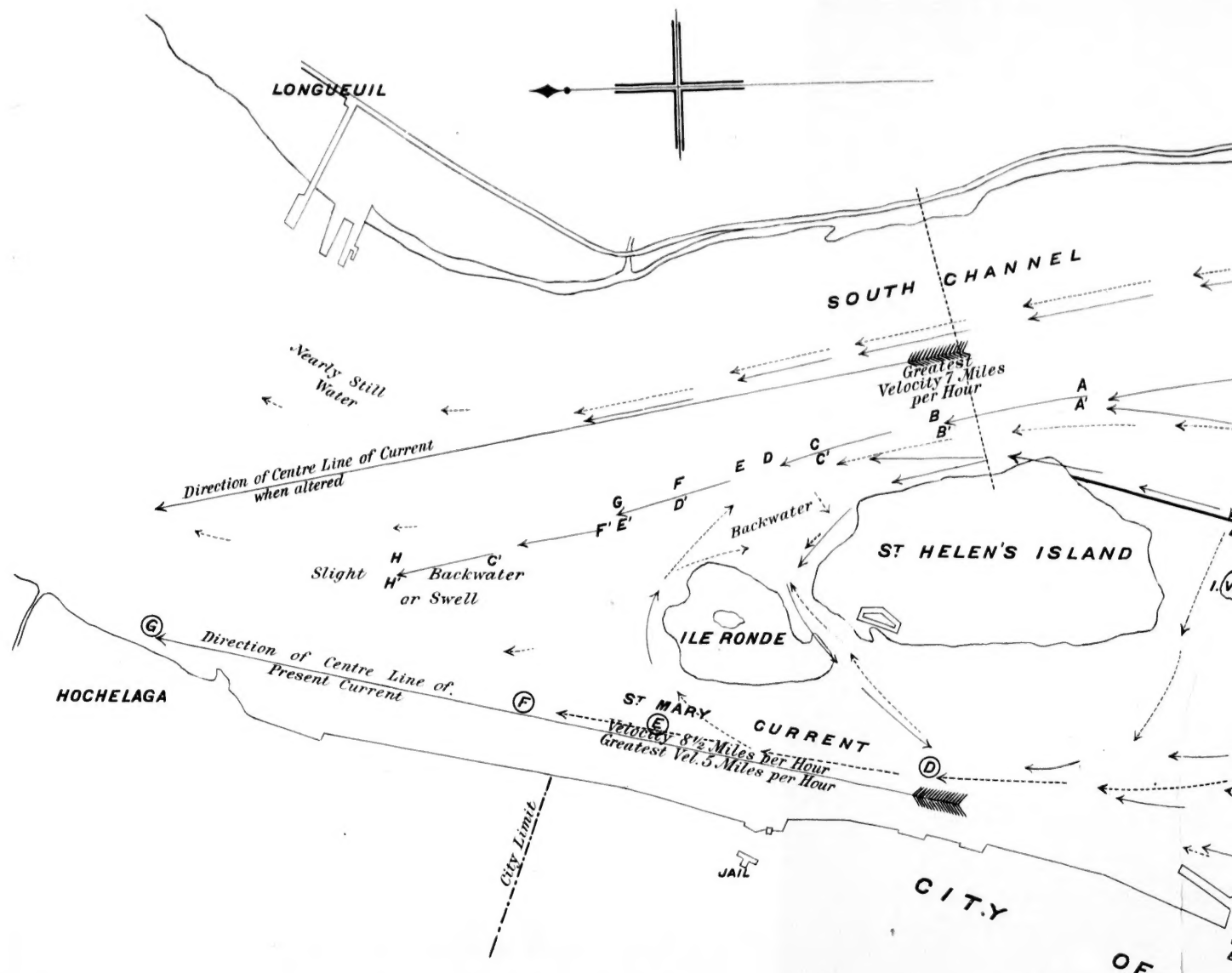


for Sections
inch.

The Works will in the first place be constructed with a single line of rails, and only such extra work will be done as may be necessitated by the demands of commerce. The drawing shows two heights, one of 50 ft. at the Bridge, original design; the other 60 ft. at the Bridge, altered design.

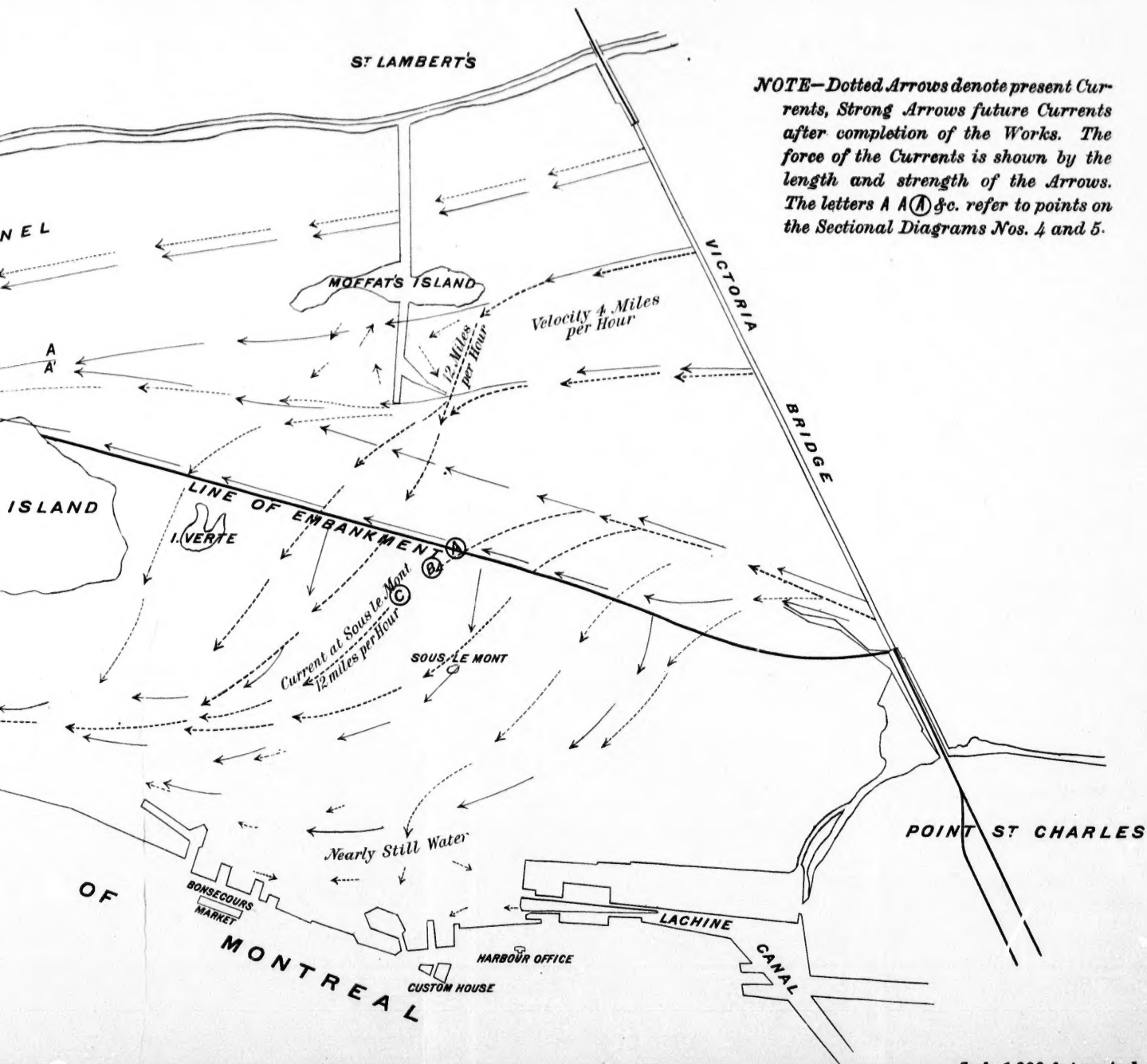


CURRENT PLAN



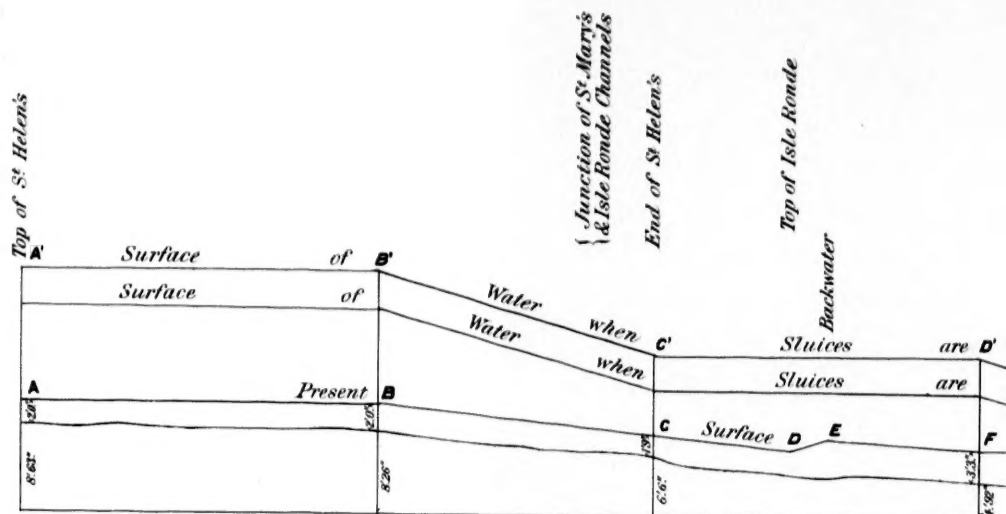
THE
ST. LAWRENCE BRIDGE AND MANUFACTURING
SCHEME.

John A. Baillie
In Charge



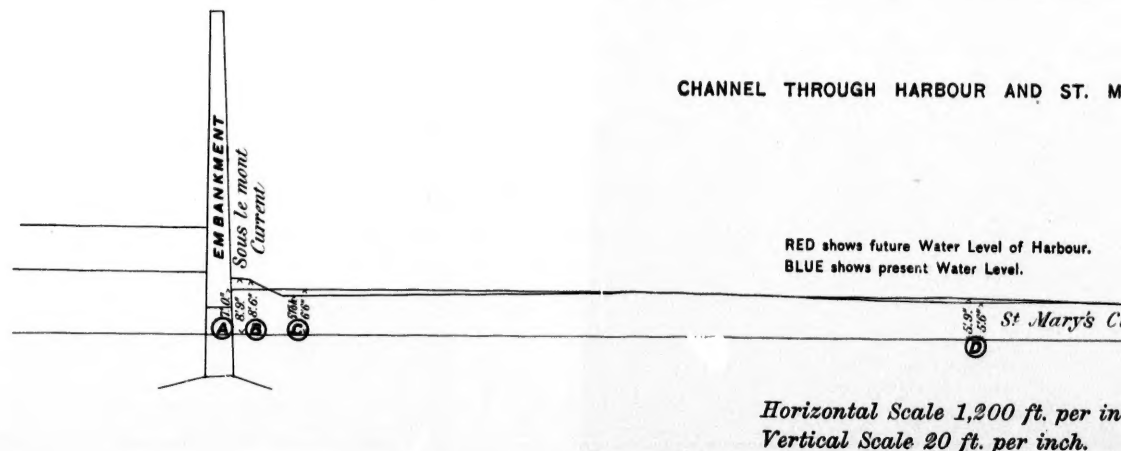
SECTIONAL DIAGRAMS

SOUTH CHANNEL PAST ST. HELEN'S AND ISLE RONDE
AT LONGUEUIL.



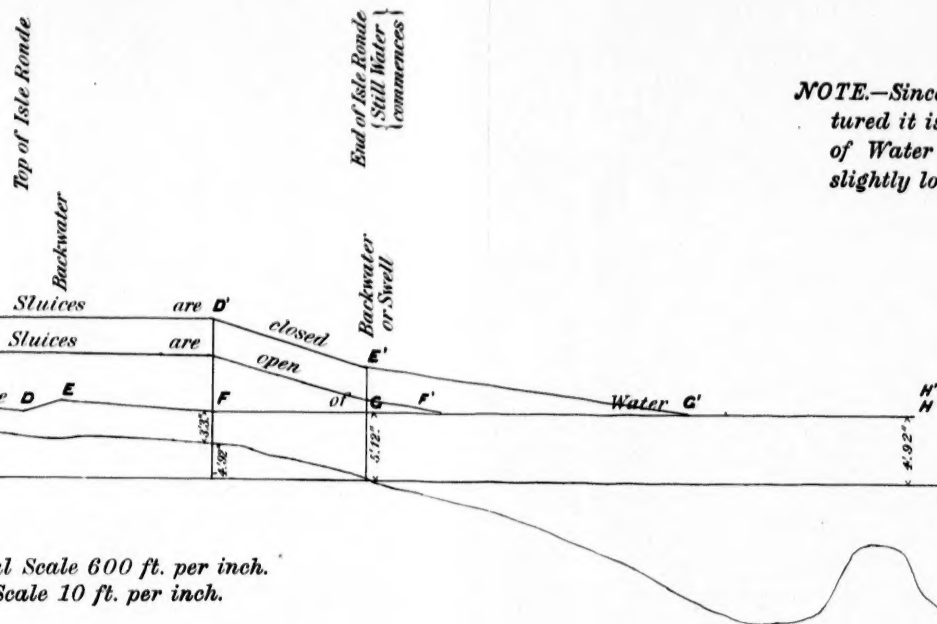
THE ST. LAWRENCE BRIDGE AND MANUFACTURING SCHEME.

Horizontal Scale 600 ft. per inch.



Nº 4.

HELEN'S AND ISLE RONDE TO STILL WATER
AT LONGUEUIL.



NOTE.—Since the Scheme has been matured it is found that the New Levels of Water in South Channel will be slightly lower than shown here.

Nº 5.

HARBOUR AND ST. MARY'S CURRENT.



Scale 1,200 ft. per inch.
Scale 20 ft. per inch.

L. C. B. L. C. S.